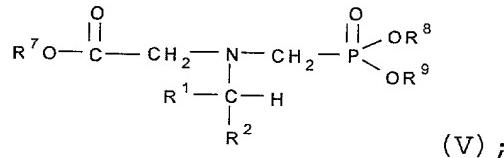


We claim:

1. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising  
5 combining an N-substituted N-(phosphonomethyl)glycine reactant with oxygen in the presence of a catalyst comprising a noble metal on a polymer support,  
wherein the N-substituted N-(phosphonomethyl)glycine reactant has formula (V) :

10



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are  
15 independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

2. The process of claim 1 wherein the polymer support comprises a basic polymer.

3. The process of claim 1 wherein the polymer support comprises a polymer selected from the group consisting of polyamide, polyimide, polycarbonate, polyurea, and polyester.

4. The process of claim 1 wherein the polymer support comprises a polymer selected from the group consisting of polyethylene imine, polyaminostyrene, sulfonated polystyrene, polyvinyl pyridine, and a salt of 5 polyacrylic acid.

5. The process of claim 1 wherein the polymer support comprises polystyrene.

6. The process of claim 1 wherein the polymer support comprises sulfonated polystyrene.

7. The process of claim 1 wherein the polymer support comprises polyvinyl pyridine.

8. The process of claim 1 wherein the polymer support comprises polystyrene substituted with dimethylamine groups.

9. The process of claim 1 wherein the catalyst further comprises a hydrophobic electroactive molecular species.

10. The process of claim 1 wherein the N-substituted N-(phosphonomethyl)glycine reactant is combined with oxygen in the presence of the catalyst and 2,2,6,6-tetramethyl piperidine N-oxide.

11. The process of claim 1 wherein the catalyst further comprises a compound selected from the group consisting of triphenylmethane; N-hydroxypthalimide; 5,10,15,20-

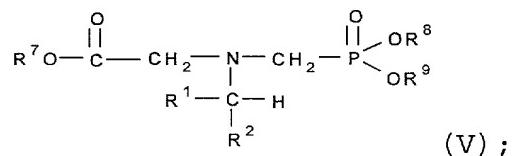
5      tetrakis(pentafluorophenyl)-21H,23H-porphine iron (III) chloride; 2,4,7-trichlorofluorene; triarylamine; 2,2,6,6-tetramethyl piperidine N-oxide; 5,10,15,20-tetraphenyl-21H,23H-porphine iron(III) chloride; 4,4'-difluorobenzophenone; 5,10,15,20-tetraphenyl-21H,23H-porphine nickel(II); and phenothiazine.  
10

12. The process of claim 1 wherein the catalyst further comprises a triarylamine.

13. The process of claim 1 wherein the catalyst further comprises tris(4-bromophenyl)amine.

14. The process of claim 1 wherein the catalyst further comprises N,N'-bis-(3-methylphenyl)-N,N'-diphenyl benzidine.

15. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising  
5      combining an N-substituted N-(phosphonomethyl)glycine reactant with oxygen in the presence of a catalyst comprising a noble metal and a promoter,  
·      wherein  
the N-substituted N-(phosphonomethyl)glycine  
10     reactant has formula (V) :



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than  
15 -CO<sub>2</sub>R<sup>15</sup>;

R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation;

20 the promoter comprises a metal selected from the group consisting of aluminum, ruthenium, osmium, indium, gallium, tantalum, tin, and antimony; and

at least about 0.05% by weight of the catalyst consists of the promoter.

16. The process of claim 15 wherein the promoter comprises indium.

17. The process of claim 15 wherein the promoter comprises gallium.

18. The process of claim 15 wherein the promoter comprises ruthenium.

19. The process of claim 15 wherein the promoter comprises osmium.

20. The process of claim 15 wherein R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and R<sup>7</sup>, R<sup>8</sup>, and R<sup>9</sup> are independently selected  
5 from the group consisting of hydrogen and an agronomically acceptable cation.

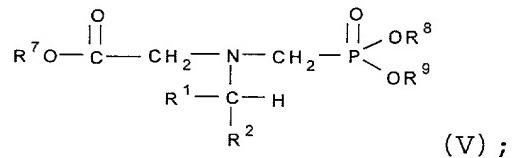
21. The process of claim 15 wherein the noble metal and promoter are on a support.

22. The process of claim 21 wherein the support comprises graphitic carbon.

23. The process of claim 21 wherein the support comprises a polymer.

24. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising:

- 5       contacting a surface of a carbon support with an oxidizing agent;
- depositing a noble metal onto the oxidized surface to form a carbon-supported oxidation catalyst; and
- combining an N-substituted N-
- 10      (phosphonomethyl)glycine reactant with oxygen in the presence of the carbon-supported oxidation catalyst,
- wherein the N-substituted N-(phosphonomethyl)glycine reactant has formula (V):



- 15       $\text{R}^1$  and  $\text{R}^2$  are independently selected from the group consisting of hydrogen, halogen,  $-\text{PO}_3\text{R}^{12}\text{R}^{13}$ ,  $-\text{SO}_3\text{R}^{14}$ ,  $-\text{NO}_2$ , hydrocarbyl, and substituted hydrocarbyl other than

-CO<sub>2</sub>R<sup>15</sup>; and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are independently selected from the group consisting of 20 hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

25. The process of claim 24 wherein the oxidizing agent comprises H<sub>2</sub>O<sub>2</sub>.

26. The process of claim 24 wherein (a) the carbon-supported oxidation catalyst further comprises a promoter, and (b) at least about 0.05% by weight of the catalyst consists of the promoter.

27. The process of claim 26 wherein the promoter comprises indium.

28. The process of claim 26 wherein the promoter comprises gallium.

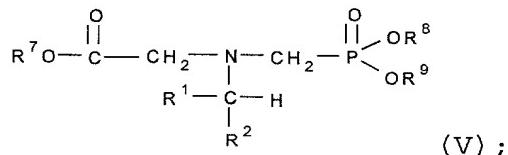
29. The process of claim 26 wherein the promoter comprises ruthenium.

30. The process of claim 26 wherein the promoter comprises osmium.

31. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising:

5 combining an N-substituted N-(phosphonomethyl)glycine mixture comprising an N-substituted N-(phosphonomethyl)glycine reactant with

oxygen in the presence of a noble metal catalyst in an oxidation reaction zone to form an N-  
10 (phosphonomethyl)glycine mixture comprising N- (phosphonomethyl)glycine, the salt of N- (phosphonomethyl)glycine, or the ester of N- (phosphonomethyl)glycine;  
separating N- (phosphonomethyl)glycine, the salt of  
15 N- (phosphonomethyl)glycine, or the ester of N- (phosphonomethyl)glycine from the N- (phosphonomethyl)glycine mixture to recover the separated N- (phosphonomethyl)glycine, salt of N- (phosphonomethyl)glycine, or ester of N-  
20 (phosphonomethyl)glycine and form a residual mixture;  
feeding at least a portion of the residual mixture back into the oxidation reaction zone,  
wherein the N-substituted N- (phosphonomethyl)glycine reactant has formula (V) :



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are  
25 independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

32. The process of claim 31 wherein when from about 20 to about 95% of the N-substituted N-

(phosphonomethyl)glycine reactant initially in the N-substituted N-(phosphonomethyl)glycine mixture has been consumed, N-(phosphonomethyl)glycine, the salt of N-(phosphonomethyl)glycine, or the ester of N-(phosphonomethyl)glycine is separated from the N-(phosphonomethyl)glycine mixture to recover the separated N-(phosphonomethyl)glycine, salt of N-(phosphonomethyl)glycine, or ester of N-(phosphonomethyl)glycine and form the residual mixture.

33. The process of claim 32 wherein N-(phosphonomethyl)glycine, the salt of N-(phosphonomethyl)glycine, or the ester of N-(phosphonomethyl)glycine is separated from the N-(phosphonomethyl)glycine mixture when from about 50 to about 90% of the N-substituted N-(phosphonomethyl)glycine reactant initially in the N-substituted N-(phosphonomethyl)glycine mixture has been consumed.

34. The process of claim 32 wherein N-(phosphonomethyl)glycine, the salt of N-(phosphonomethyl)glycine, or the ester of N-(phosphonomethyl)glycine is separated from the N-(phosphonomethyl)glycine mixture when from about 50 to about 80% of the N-substituted N-(phosphonomethyl)glycine reactant initially in the N-substituted N-(phosphonomethyl)glycine mixture has been consumed.

35. The process of claim 32 wherein N-(phosphonomethyl)glycine, the salt of N-(phosphonomethyl)glycine, or the ester of N-(phosphonomethyl)glycine is separated from the N-

5 (phosphonomethyl)glycine mixture when from about 50 to  
about 70% of the N-substituted N-(phosphonomethyl)glycine  
reactant initially in the N-substituted N-  
(phosphonomethyl)glycine mixture has been consumed.

36. The process of claim 31 wherein the  
residual mixture is divided into a recycle mixture and a  
waste mixture by being pressurized and contacted with a  
membrane which selectively passes a contaminant from the  
5 residual mixture while retaining (a) the N-substituted N-  
(phosphonomethyl)glycine reactant, and (b) N-  
(phosphonomethyl)glycine, the salt of N-  
(phosphonomethyl)glycine, or the ester of N-  
(phosphonomethyl)glycine, wherein

10 the waste mixture comprises any portion of the  
residual mixture which passes through the membrane; and  
the recycle mixture (a) comprises any portion of the  
residual mixture which does not pass through the  
membrane, and (b) comprises the portion of the residual  
15 mixture which is fed back into the oxidation reaction  
zone.

37. The process of claim 36 wherein the  
contaminant is a salt.

38. The process of claim 31 wherein the  
residual mixture is divided into a recycle mixture and a  
waste mixture by being pressurized and contacted with a  
membrane having a molecular weight cutoff of less than  
5 about 1,000 daltons, wherein

the waste mixture comprises any portion of the  
residual mixture which passes through the membrane; and

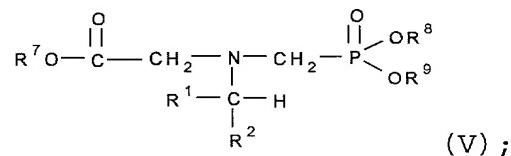
the recycle mixture (a) comprises any portion of the residual mixture which does not pass through the membrane, and (b) comprises the portion of the residual mixture which is fed back into the oxidation reaction zone.

39. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising introducing oxygen into a mixture comprising an N-substituted N-(phosphonomethyl)glycine reactant and a noble metal catalyst,

wherein

the oxygen is introduced into the mixture through a membrane;

the N-substituted N-(phosphonomethyl)glycine reactant has formula (V) :



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and

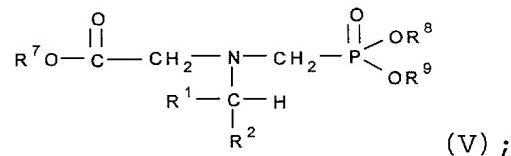
R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

40. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising forming a reaction mixture by combining an N-substituted N-(phosphonomethyl)glycine reactant with oxygen in the presence of a noble metal catalyst,

5 wherein

no greater than about 10% by volume of the reaction mixture consists of undissolved oxygen;

10 the N-substituted N-(phosphonomethyl)glycine reactant has formula (V) :



15  $\text{R}^1$  and  $\text{R}^2$  are independently selected from the group consisting of hydrogen, halogen,  $-\text{PO}_3\text{R}^{12}\text{R}^{13}$ ,  $-\text{SO}_3\text{R}^{14}$ ,  $-\text{NO}_2$ , hydrocarbyl, and substituted hydrocarbyl other than  $-\text{CO}_2\text{R}^{15}$ ; and

20  $\text{R}^7$ ,  $\text{R}^8$ ,  $\text{R}^9$ ,  $\text{R}^{12}$ ,  $\text{R}^{13}$ ,  $\text{R}^{14}$ , and  $\text{R}^{15}$  are independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

41. The process of claim 40 wherein no greater than about 4% by volume of the reaction mixture consists of undissolved oxygen.

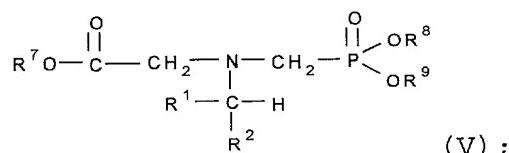
42. The process of claim 40 wherein no greater than about 1% by volume of the reaction mixture consists of undissolved oxygen.

43. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising  
5 introducing oxygen into a mixture comprising an N-substituted N-(phosphonomethyl)glycine reactant and a noble metal catalyst in a stirred tank reactor,

wherein

the oxygen is introduced into the mixture as gas bubbles in a manner such that essentially no gas bubbles enter a region of the reactor through which an impeller passes;

the N-substituted N-(phosphonomethyl)glycine reactant has formula (V) :



15

R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and

20 R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>12</sup>, R<sup>13</sup>, R<sup>14</sup>, and R<sup>15</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

44. A process for the preparation of N-(phosphonomethyl)glycine, a salt of N-(phosphonomethyl)glycine, or an ester of N-(phosphonomethyl)glycine, the process comprising:

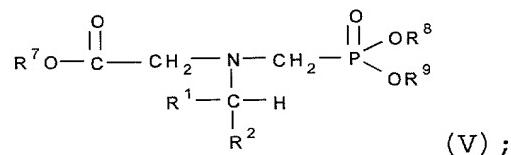
5        combining an N-substituted N-(phosphonomethyl)glycine reactant with oxygen in the presence of a noble metal catalyst in an oxidation reaction zone to form an oxidation product comprising (a) a ketone, and (b) N-(phosphonomethyl)glycine, the salt of N-(phosphonomethyl)glycine, or the ester of N-(phosphonomethyl)glycine;

10      separating the ketone from the oxidation product to recover the ketone;

15      using the recovered ketone as a starting material to form the N-substituted N-(phosphonomethyl)glycine reactant; and

20      combining the N-substituted N-(phosphonomethyl)glycine reactant derived from the ketone with oxygen in the presence of the noble metal catalyst in the oxidation reaction zone,

wherein the N-substituted N-(phosphonomethyl)glycine reactant has formula (V) :



the ketone has formula (VIII) :



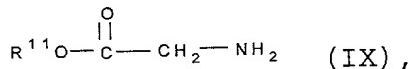
R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrocarbyl and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, and R<sup>15</sup> are independently selected from the group consisting of 30 hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

45. The process of claim 44 wherein R<sup>7</sup>, R<sup>8</sup>, and R<sup>9</sup> are independently selected from the group consisting of hydrogen and an agronomically acceptable cation.

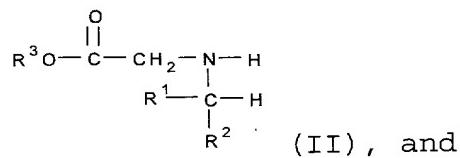
46. The process of claim 44 wherein R<sup>1</sup> is methyl, and R<sup>2</sup> is selected from the group consisting of methyl and ethyl.

47. The process of claim 44 wherein:  
the ketone is combined with H<sub>2</sub> and a glycine reactant in the presence of a metal-containing catalyst to form an N-substituted glycine reactant, and

5 the N-substituted glycine reactant is phosphonomethylated to form the N-substituted N-(phosphonomethyl)glycine reactant,  
wherein the glycine reactant has formula (IX) :



10 the N-substituted glycine reactant has formula (II) :



R<sup>3</sup> and R<sup>11</sup> are independently selected from the group consisting of hydrogen and an agronomically acceptable cation.

48. The process of claim 47 wherein the metal-containing catalyst comprises a metal selected from the group consisting of platinum and palladium.

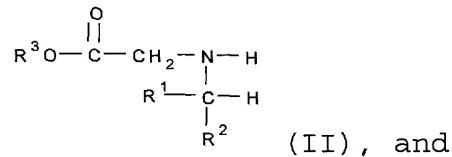
49. The process of claim 44 wherein:  
the ketone is combined with H<sub>2</sub> and ammonia in the presence of a metal-containing catalyst to form a primary amine,

5 the primary amine is combined with HCN and a source of CH<sub>2</sub>O to form a nitrile,

the nitrile is hydrolyzed to form an N-substituted glycine reactant, and

10 the N-substituted glycine reactant is phosphonomethylated to form the N-substituted N-(phosphonomethyl)glycine reactant,

wherein the N-substituted glycine reactant has formula (II):



15 R<sup>3</sup> is selected from the group consisting of hydrogen and an agronomically acceptable cation.

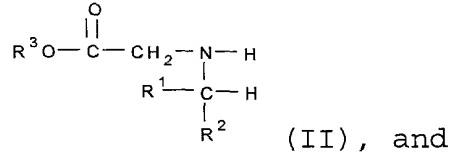
50. The process of claim 44 wherein:

the ketone is combined with H<sub>2</sub> and ammonia in the presence of a first catalyst comprising a metal to form a primary amine,

- 5        the primary amine is converted into an amide,  
          the amide is combined with CO and a source of CH<sub>2</sub>O in the presence of a second catalyst comprising a metal selected from the group consisting of cobalt and palladium to form an N-substituted glycine amide,

- 10      the N-substituted glycine amide is hydrolyzed to form an N-substituted glycine reactant, and  
          the N-substituted glycine reactant is phosphonomethylated to form the N-substituted N-(phosphonomethyl)glycine reactant,

- 15      wherein the N-substituted glycine reactant has formula (II):

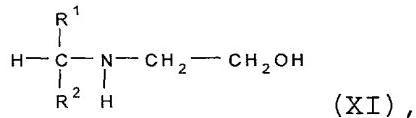


R<sup>3</sup> is selected from the group consisting of hydrogen and an agronomically acceptable cation.

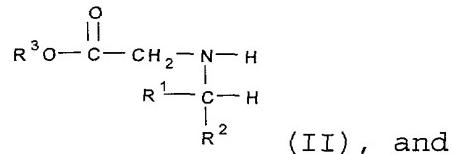
51.     The process of claim 44 wherein:  
          the ketone is combined with H<sub>2</sub> and monoethanolamine in the presence of a metal-containing catalyst to form an N-substituted monoethanolamine,  
5        the N-substituted monoethanolamine is combined with a strong base in the presence of a catalyst comprising copper to form an N-substituted glycine reactant, and

the N-substituted glycine reactant is  
phosphonomethylated to form the N-substituted N-  
10 (phosphonomethyl)glycine reactant,

wherein the N-substituted monoethanolamine has  
formula (XI) :



the N-substituted glycine reactant has formula (II) :



15  $\text{R}^3$  is selected from the group consisting of hydrogen and  
an agronomically acceptable cation.

52. The process of claim 51 wherein the base  
comprises NaOH.

53. The process of claim 51 wherein the  
ketone, monoethanolamine, and  $\text{H}_2$  are combined essentially  
in the absence of any non-reactive solvent.

54. The process of claim 53 wherein the ketone  
is acetone.

55. A process for the preparation of N-  
(phosphonomethyl)glycine or a salt thereof, the process  
comprising:

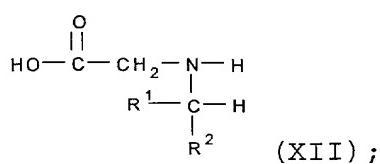
converting an N-substituted glycine salt into an N-  
5 substituted glycine free acid,

phosphonomethylating the N-substituted glycine free acid to form an N-substituted N-(phosphonomethyl)glycine, and

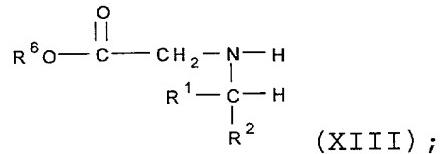
10 combining the N-substituted N-(phosphonomethyl)glycine or a salt thereof with oxygen in the presence of a noble metal catalyst in an oxidation reaction zone,

wherein the N-substituted glycine free acid has formula (XII) :

15

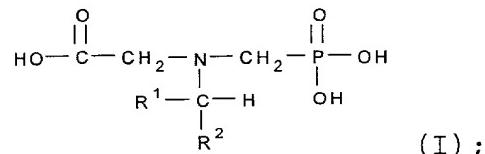


the N-substituted glycine salt has formula (XIII) :



the N-substituted N-(phosphonomethyl)glycine has formula (I) :

20



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; R<sup>6</sup> is an agronomically acceptable cation; R<sup>12</sup>, R<sup>13</sup>, and R<sup>14</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, and substituted hydrocarbyl; and R<sup>15</sup> is selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

56. The process of claim 55 wherein the N-substituted glycine salt is converted into the N-substituted glycine free acid by contacting a mixture comprising the N-substituted glycine salt with a first side of a cation exchange membrane while simultaneously contacting a second side of the cation exchange membrane with an N-substituted N-(phosphonomethyl)glycine mixture comprising (a) the N-substituted N-(phosphonomethyl)glycine or the salt thereof, and (b) a strong acid having a pK<sub>a</sub> of no greater than about 1.0.

57. The process of claim 56 wherein the strong acid comprises H<sub>2</sub>SO<sub>4</sub>.

58. The process of claim 56 wherein, after being contacted with the second side of the cation exchange membrane, the N-substituted N-(phosphonomethyl)glycine mixture is combined with oxygen in the presence of the noble metal in the oxidation reaction zone.

59. The process of claim 58 wherein R<sup>1</sup> is methyl, and R<sup>2</sup> is selected from the group consisting of methyl and ethyl.

60. The method of claim 58 wherein the N-substituted N-(phosphonomethyl)glycine mixture does not contain a halogen.

61. The process of claim 55 wherein the N-substituted glycine salt is converted into the N-substituted glycine free acid by contacting a mixture comprising the N-substituted glycine salt with a first side of a cation exchange membrane while simultaneously contacting a second side of the cation exchange membrane with a mixture comprising a strong acid having a pK<sub>a</sub> of no greater than about 1.0.

62. The process of claim 55 wherein the N-substituted glycine salt is converted into the N-substituted glycine free acid by a process comprising:  
5 combining PCl<sub>3</sub> and water to form a PCl<sub>3</sub> hydrolysis mixture comprising H<sub>3</sub>PO<sub>3</sub> and HCl;  
separating HCl from the PCl<sub>3</sub> hydrolysis mixture to form an H<sub>3</sub>PO<sub>3</sub>-containing mixture and an HCl-containing mixture; and  
contacting the HCl-containing mixture with a first  
10 side of a cation exchange membrane while simultaneously contacting a second side of the cation exchange membrane with a mixture comprising the N-substituted glycine salt.

63. The method of claim 62 wherein R<sup>1</sup> and R<sup>2</sup> are hydrogen.

64. A process for the preparation of an N-substituted N-(phosphonomethyl)glycine or a salt thereof, the process comprising:

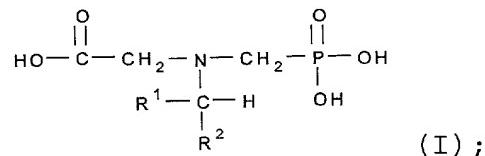
combining a source of  $H_3PO_3$ , a source of  $CH_2O$ , and an  
5 N-substituted glycine salt in a reaction zone to form a first mixture which comprises (a) the N-substituted N-(phosphonomethyl)glycine or the salt thereof, and (b) a salt precipitate;

separating salt precipitate from the first mixture  
10 to form a second mixture which comprises the N-substituted N-(phosphonomethyl)glycine or the salt thereof;

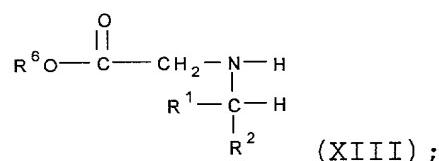
15 adding a base to the second mixture to precipitate N-substituted N-(phosphonomethyl)glycine or the salt thereof; and

separating the precipitated N-substituted N-(phosphonomethyl)glycine or salt thereof from the second mixture to recover the precipitated N-substituted N-(phosphonomethyl)glycine or salt thereof and form a residual mixture,

20 wherein the N-substituted N-(phosphonomethyl)glycine has formula (I) :



the N-substituted glycine salt has formula (XIII) :



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; R<sup>6</sup> is an agronomically acceptable cation; R<sup>12</sup>, R<sup>13</sup>, and R<sup>14</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, and substituted hydrocarbyl; and R<sup>15</sup> is selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

65. The process of claim 64 wherein the source of H<sub>3</sub>PO<sub>3</sub> comprises PCl<sub>3</sub>.

66. The process of claim 64 wherein the salt precipitate comprises chlorine.

67. The process of claim 64 wherein R<sup>1</sup> and R<sup>2</sup> are hydrogen.

68. The process of claim 64 wherein R<sup>1</sup> is methyl and R<sup>2</sup> is hydrogen.

69. The process of claim 64 wherein R<sup>1</sup> is methyl and R<sup>2</sup> is selected from the group consisting of methyl and ethyl.

70. The process of claim 64 wherein at least a portion of the residual mixture is recycled to the reaction zone.

71. The process of claim 64 further comprising the preparation of N-(phosphonomethyl)glycine or a salt thereof by a process comprising combining the recovered N-substituted N-(phosphonomethyl)glycine or the salt thereof with oxygen in the presence of a noble metal catalyst.

72. A process for the preparation of an N-substituted N-(phosphonomethyl)glycine or a salt thereof, the process comprising:

combining a source of  $H_3PO_4$ , and an N-substituted glycine salt in a reaction zone to form a first mixture which comprises (a) an N-substituted glycine free acid, and (b) a salt precipitate;

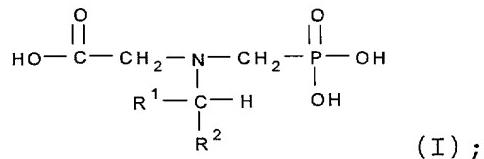
separating salt precipitate from the first mixture to form a second mixture comprising the N-substituted glycine free acid;

adding a source of  $CH_3CO$  to the second mixture to form a third mixture which comprises the N-substituted N-(phosphonomethyl)glycine or the salt thereof;

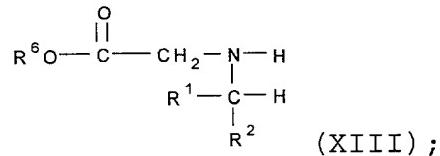
adding a base to the third mixture to precipitate N-substituted N-(phosphonomethyl)glycine or the salt thereof; and

separating precipitated N-substituted N-(phosphonomethyl)glycine or the salt thereof from the third mixture to recover the precipitated N-substituted N-(phosphonomethyl)glycine or salt thereof and form a residual mixture;

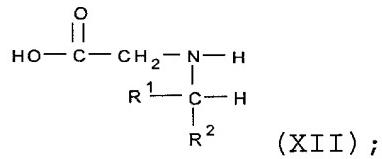
wherein the N-substituted N-(phosphonomethyl)glycine has formula (I) :



25 the N-substituted glycine salt has formula (XIII) :



the N-substituted glycine free acid has formula (XII) :



R<sup>1</sup> and R<sup>2</sup> are independently selected from the group consisting of hydrogen, halogen, -PO<sub>3</sub>R<sup>12</sup>R<sup>13</sup>, -SO<sub>3</sub>R<sup>14</sup>, -NO<sub>2</sub>, hydrocarbyl, and substituted hydrocarbyl other than -CO<sub>2</sub>R<sup>15</sup>; R<sup>6</sup> is an agronomically acceptable cation; R<sup>12</sup>, R<sup>13</sup>, and R<sup>14</sup> are independently selected from the group consisting of hydrogen, hydrocarbyl, and substituted hydrocarbyl; and R<sup>15</sup> is selected from the group consisting of hydrogen, hydrocarbyl, substituted hydrocarbyl, and an agronomically acceptable cation.

73. The process of claim 72 wherein the source of H<sub>3</sub>PO<sub>3</sub> comprises PCl<sub>3</sub>.

74. The process of claim 72 wherein the salt precipitate comprises chlorine.

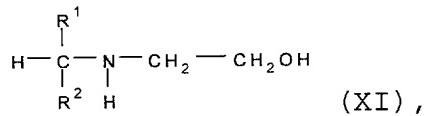
75. The process of claim 72 wherein R<sup>1</sup> and R<sup>2</sup> are hydrogen.

76. The process of claim 72 wherein R<sup>1</sup> is methyl and R<sup>2</sup> is hydrogen.

77. The process of claim 72 wherein at least a portion of the residual mixture is recycled to the reaction zone.

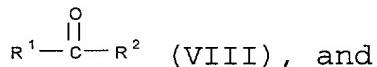
78. The process of claim 72 further comprising the preparation of N-(phosphonomethyl)glycine or a salt thereof by a process comprising combining the recovered N-substituted N-(phosphonomethyl)glycine or the salt thereof with oxygen in the presence of a noble metal catalyst.

79. A process for the preparation of an N-substituted monoethanolamine, the process comprising combining a ketone, monoethanolamine, and H<sub>2</sub> in the presence of a metal-containing catalyst and essentially in the absence of any non-reactive solvent,  
wherein the N-substituted monoethanolamine has formula (XI) :



the ketone has formula (VIII):

10



$\text{R}^1$  and  $\text{R}^2$  are independently selected from the group consisting of hydrocarbyl and substituted hydrocarbyl.

80. The process of claim 79 wherein the metal-containing catalyst comprises a metal selected from the group consisting of palladium and platinum.

81. The process of claim 79 wherein the ketone is acetone.

82. An oxidation catalyst comprising a noble metal and an electroactive molecular species.

83. The oxidation catalyst of claim 82 wherein the electroactive molecular species is hydrophobic.

84. The oxidation catalyst of claim 82 wherein the electroactive molecular species has an oxidation potential of at least about 0.3 volts vs. SCE.

85. The oxidation catalyst of claim 82 wherein the electroactive molecular species comprises a compound selected from the group consisting of triphenylmethane; N-hydroxyphthalimide; 2,4,7-trichlorofluorene; tris(4-bromophenyl)amine; 2,2,6,6-tetramethyl piperidine N-oxide; 5,10,15,20-tetraphenyl-21H,23H-porphine iron(III) chloride; 5,10,15,20-tetraphenyl-21H,23H porphine nickel(II); 4,4'-difluorobenzophenone; 5,10,15,20-

tetrakis(pentafluorophenyl)-21H,23H-porphine iron (III)  
10 chloride; and phenothiazine.

86. The oxidation catalyst of claim 82 wherein  
the electroactive molecular species comprises 2,2,6,6-  
tetramethyl piperidine N-oxide.

87. The oxidation catalyst of claim 82 wherein  
the electroactive molecular species comprises a  
triarylamine.

88. The oxidation catalyst of claim 82 wherein  
the electroactive molecular species comprises N,N'-bis(3-  
methylphenyl)-N,N'-diphenyl benzidine.

89. The oxidation catalyst of claim 82 wherein  
(a) the catalyst further comprises a promoter, and (b) at  
least about 0.05% by weight of the catalyst consists of  
the promoter.

90. The oxidation catalyst of claim 89 wherein  
the promoter comprises a metal selected from the group  
consisting of aluminum, ruthenium, osmium, indium,  
gallium, tantalum, tin, and antimony.

91. The oxidation catalyst of claim 82 further  
comprising a support comprising a material selected from  
the group consisting of carbon, alumina, silica, titania,  
zirconia, siloxane, and barium sulfate.

92. The oxidation catalyst of claim 91 wherein  
the support comprises a material selected from the group

consisting of alumina, silica, titania, zirconia, siloxane, and barium sulfate.

93. The oxidation catalyst of claim 91 wherein the support comprises a material selected from the group consisting of silica, titania, and barium sulfate.

94. The oxidation catalyst of claim 91 wherein the support comprises graphitic carbon.

95. The oxidation catalyst of claim 82 wherein the noble metal is on a support which comprises a polymer.

96. The oxidation catalyst of claim 95 wherein the support comprises a polymer selected from the group consisting of polyamide, polyimide, polycarbonate, polyurea, and polyester.

97. The oxidation catalyst of claim 95 wherein the support comprises a polymer selected from the group consisting of polyethylene imine, polyaminostyrene, sulfonated polystyrene, polyvinyl pyridine, and a salt of polyacrylic acid.

98. The oxidation catalyst of claim 95 wherein the support comprises polystyrene.

99. The oxidation catalyst of claim 95 wherein the support comprises polystyrene substituted with dimethylamine groups.